MULTIMEDIA UNIVERSITY

STUDENT ID NO

MULTIMEDIA UNIVERSITY

FINAL EXAMINATION

TRIMESTER 3 , 2021/2022

DPM5036 – CONTROL SYSTEMS

(DEE)

09 AUGUST 2022
9.00 a.m. – 11.00 a.m.
(2 Hours)

INSTRUCTIONS TO STUDENT

1. This Question paper consists of **6 pages** including cover page and Appendix with **4 Questions** only.

2. Attempt **ALL** questions. The distribution of the marks for each question is given.

3. Please write all your answers in the Answer Booklet provided.

Question 1

(a) Reduce the system's block diagram, as shown in **Figure Q1 (a),** into a single transfer function.

[11 marks]

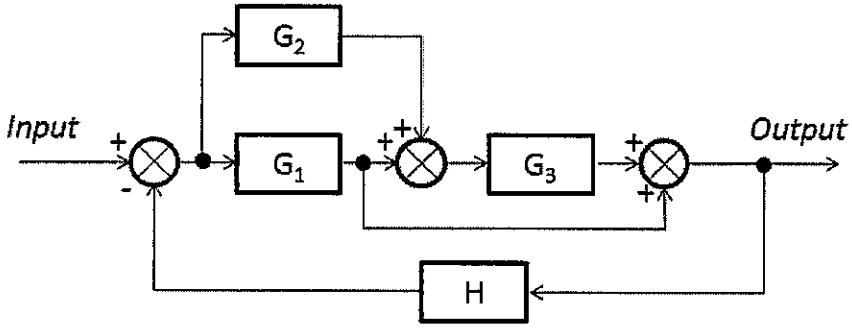

Figure Q1 (a) A Typical System's Block Diagram

(b) Determine the transfer function of $G(s) = \theta_2(s)/T(s)$ for the mechanical system (Rational) shown in **Figure Q1 (b).** (Hints: assume zero initial condition)

[14 marks]

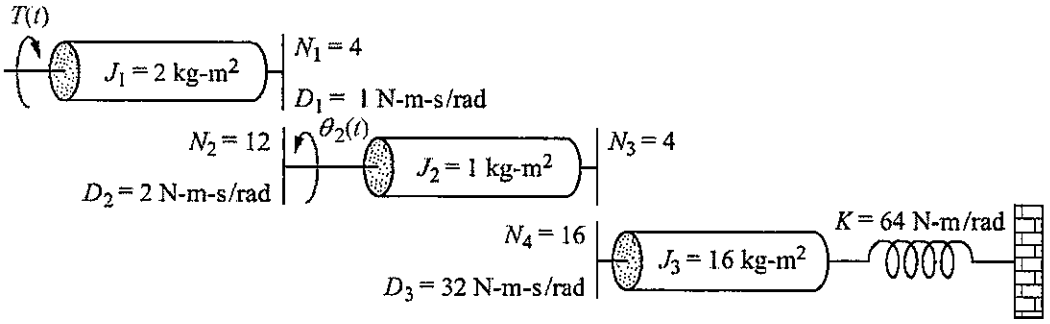

Figure. Q1(b)

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Question 2

(a) For the system shown in **Figure Q2 (a)**, find the peak time and percent overshoot.

[8 marks]

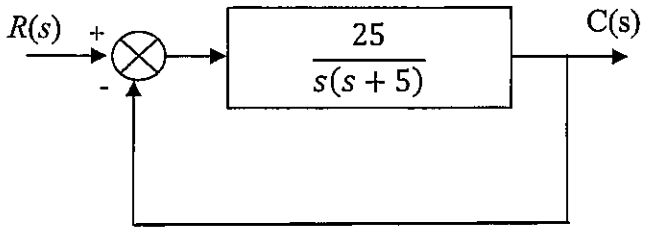


Figure Q2 (a)

(b) A negative unity feedback system has an open loop transfer function:

$$G(s) = \frac{12}{s^3 + K s^2 + 5s}$$

By using the Routh-Hurwitz stability criterion, determine the range of K for a stable system.

[7 marks]

(c) **Figure Q2 (c)** shows a control system used in a manufacturing industry. Evaluate the static error constants and determine the steady-state error for the unit step, ramp, and parabolic inputs.

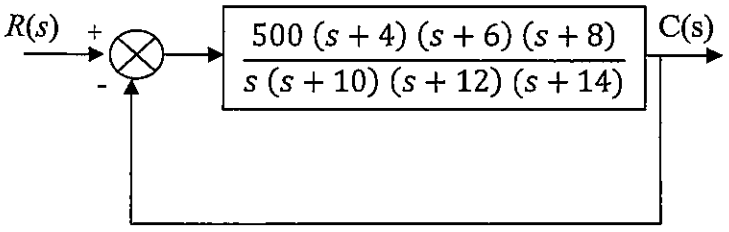


Figure Q2 (c)

[10 marks]

Continued ...

Question 3

Consider a negative unity feedback control system with the following characteristic equation:

$$1 + \mathrm{K}\ \mathbf{G(s)} = 1 + \frac{\mathrm{K}\,(\mathbf{s+4})}{(\mathbf{s+1})^2} = 0$$

Construct and label the root locus of the system. [*All eight rules of root locus construction analysis must be shown. Justify your answer if particular rule is not required.*]

[25 marks]

Question 4

Consider the open-loop transfer function

$$\mathrm{G(s)} = \frac{100}{\mathrm{s}\,(\mathrm{s}^2 + 25\mathrm{s} + 100)}$$

Sketch the asymptotic Bode plot of $\mathbf{G(s)}$ on a semi-log graph paper. Provide all the details on the magnitude and phase angle of each basic factors.

[25 marks]

Continued ...

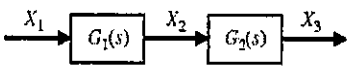
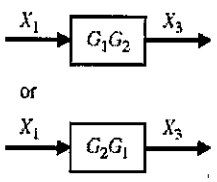
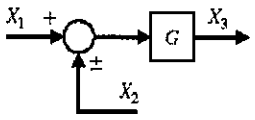
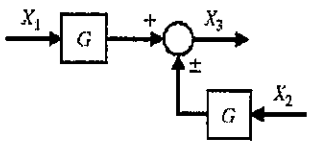
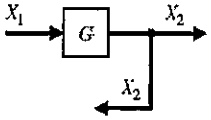
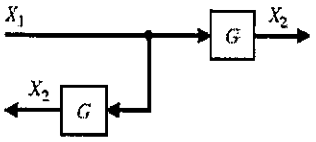
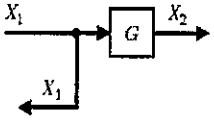
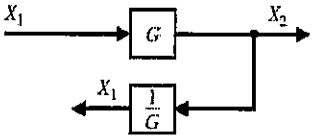
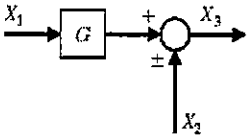
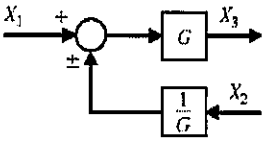
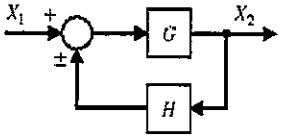
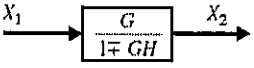
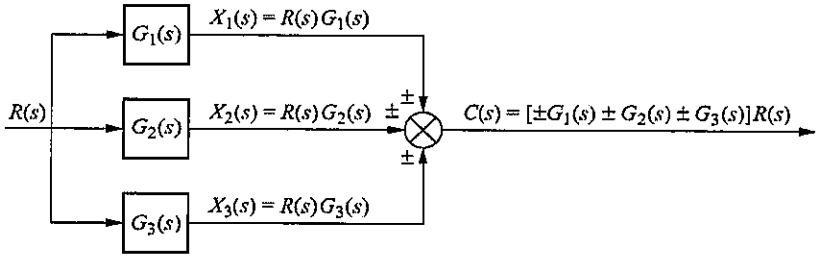
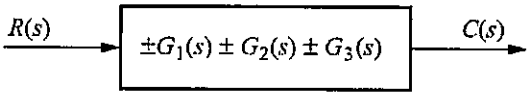
APPENDIX

TABLE 1: **Laplace Transform Pairs**

f(t)	F(s)
Unit impulse δ (t)	1
Unit step u(t)	$\frac{1}{s}$
t	$\frac{1}{s^2}$
$\frac{t^{n-1}}{(n-1)!}$ (n = 1, 2, 3, …)	$\frac{1}{s^n}$
t^n (n = 1, 2, 3, …)	$\frac{n!}{s^{n+1}}$
e^{-at}	$\frac{1}{s+a}$
te^{-at}	$\frac{1}{(s+a)^2}$
$\sin \omega t$	$\frac{\omega}{s^2+\omega^2}$
$\cos \omega t$	$\frac{s}{s^2+\omega^2}$
$e^{-at} \sin \omega t$	$\frac{\omega}{(s+a)^2+\omega^2}$
$e^{-at} \cos \omega t$	$\frac{s+a}{(s+a)^2+\omega^2}$
$1-\cos \omega t$	$\frac{\omega^2}{s(s^2+\omega^2)}$
$\omega t-\sin \omega t$	$\frac{\omega^3}{s^2(s^2+\omega^2)}$
$t \cos \omega t$	$\frac{s^2-\omega^2}{(s^2+\omega^2)^2}$
y'	$sY(s)-y(0)$
y''	$s^2Y(s)-sy(0)-y'(0)$
y'''	$s^3Y(s)-s^2y(0)-sy'(0)-y''(0)$

Continued …

TABLE 2: **Block diagram transformations**

Transformation	Original Diagram	Equivalent Diagram
1. Combining blocks in cascade		
2. Moving a summing point behind a block		
3. Moving a pickoff point ahead of a block		
4. Moving a pickoff point behind a block		
5. Moving a summing point ahead of a block		
6. Eliminating a feedback loop		
7. Combining blocks in parallel	Original diagram:  Equivalent diagram: 	

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